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Breeding the British golden bee in Rippi!



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BREEDING THE BRITISH GOLDEN BEE in Ripple Court Apiary.

HOW MATING IS CONTROLLED.

By
F. W. L. SLADEN,
F.E.S.

"There can be no doubt that crossing, with the aid of rigorous selection during several generations, has been a potent means in modifying old races and in forming new ones."—CHARLES DARWIN.

Breeding together successive generations of bees that gather the most honey, with the object of obtaining and improving a variety that will gather more honey than ordinary bees in the British climate—which during the season of bee-activity is cooler, more windy, and more cloudy than that of other countries in which bees are bred—has been carried on in Ripple Court Apiary, near Dover, from about 1892 until the present time. The work was begun with English-Italian hybrids, these having been found often to produce larger honey-yields than ordinary English bees and the queens to be more prolific. During 1901, 1902, and 1903 these bees were crossed with a good strain of American Goldens. Since 1903 none but queens bred in Ripple Court Apiary have been allowed to produce queens and drones there. In order to ensure the fathers being of selected parentage, it was found necessary to maintain the golden colour, because by no other means can the progeny of queens mated with drones of selected parentage be readily distinguished from the progeny of those mated with ordinary English black drones. A golden bee, differing in many respects from the American variety, has been the result.

One new generation is bred each year. About fifty golden-coloured queens, bred the previous season from the best honey-gathering parentages and producing mostly or only golden-coloured workers, have the honey-gathering characters of their colonies carefully compared in May and June, attention being also paid to hardiness and prolificness. As many drones as possible are bred from about six or seven of the best of these queens and the queens from three or four of the very best, a few queens and drones being also bred, chiefly earlier in the season, from a particularly good breeding queen or two of the previous year.

In recent years records have been made of the colouring of the workers produced by the queens mated at Ripple Court Apiary under various conditions. These records have shed some useful light on the conditions under which select matings take place, making it possible to secure them better and more easily than formerly.

The subjoined tables give the records of the matings of all the golden-coloured queens of known parentage, mated from, and tested in, small nuclei in Ripple Court Apiary in 1908:—

QUEENS OF "V" PARENTAGE.

This parentage produced only golden-coloured queens and workers.

No. of queen.	Date queen appeared to have been mated.	Weather at this date.	Approximate proportion of golden to intermediate coloured workers produced.	Age mated.
1	July 19	R	10 golden to 0 intermediate	12 days
2	" 22	R	8 "	15 "
3	" 23	F	5 "	16 "
4	" 23	F	0 "	16 "
5	" 24	F	3 "	9 "
6	" 25	F	8 "	8 "
7	" 25	F	3 "	7 "
8	" 28	E	5 "	20 "
9	" 30	F	7 "	9 "
10	" 30	F	5 "	9 "
11	Aug. 4	F	10 "	6 "
12	" 4	F	7 "	9 "
13	" 4	F	9 "	6 "
14	" 4	F	1 "	9 "
15	" 4	F	5 "	7 "
16	" 9	FR	0 "	14 "
17	" 9	FR	10 "	8 "
18	" 9	FR	8 "	8 "
19	" 9	FR	10 "	8 "
20	" 17	R	10 "	13 "
21	" 17	R	10 "	13 "
22	" 17	R	10 "	12 "
23	" 17	R	9 "	13 "
24	" 17	R	9 "	16 "
25	" 17	R	10 "	16 "
26	" 19	R	10 "	15 "
27	" 19	R	10 "	15 "
28	" 27	R	3 "	15 "
29	Sept. 6	R	10 "	13 "
30	" 6 to 8	R	9 "	25 to 27 "
31	" 6 to 8	R	9 "	19 to 21 "
32	" 8	R	10 "	15 "

QUEEN OF "D" PARENTAGE.

This parentage produced only golden-coloured queens and workers.

33	July 6	FR	8 golden to 2 intermediate	16 days
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QUEENS OF "A" PARENTAGE.

This parentage produced about nine goldens to one intermediate.

34	July 12	FR	3 golden to 7 intermediate	18 days
35	Aug. 4	F	3 "	6 "
36	" 4	F	8 "	6 "
37	" 4	F	8 "	6 "
38	" 9	FR	10 "	11 "
39	" 9	FR	9 "	11 "
40	" 9	FR	2 "	8 "
41	" 17	R	10 "	19 "

QUEENS OF "R" PARENTAGE.

This parentage produced about eight goldens to two intermediates.

42	July	6	FR	8 golden to	2 intermediate	10 days.
43	"	12	FR	8	2	11
44	"	15	R	10	0	14
45	"	22	R	9	1	21
46	"	25	F	10	0	24

QUEENS OF "C" PARENTAGE.

This parentage produced about seven goldens to three intermediates.

47	July	24	F	1 golden to	9 intermediate	12 days.
48	Aug.	17	E	8	2	12
49	"	17	R	5	5	12
50	"	22	FR	0	10 bright	11

QUEENS OF "C" PARENTAGE (*continued*).

51	Aug.	22	FR	10 golden to	0 intermediate	15 days.
52	"	22	FR	7	3	11
53	Sept.	6	R	10	0	30
54	"	6 to 8	R	1	9	22 to 24.

QUEENS OF "T" PARENTAGE.

This parentage produced about six goldens to four intermediates.

55	July	20	R	All b'tw'n golden and intermediate	17 days.
56	"	23	F	0 golden to	10
57	"	23	F	0	10
58	"	25	F	7	3
59	"	25	F	5	5

Note.—In most cases the goldens include some dark goldens, and the intermediates some bright intermediates. No blacks and very few dark intermediates were produced.

ANALYSIS OF THE ABOVE TABLES.

Mated in	Free Mating Weather (F.)		Less Free Mating Weather (FR.)		Restricted Mating Weather (R.)		TOTAL.	
	Golden.	Intermediate.	Golden.	Intermediate.	Golden.	Intermediate.	Golden.	Intermediate.
JULY.	36	44	—	—	18	2	54	46
	—	—	8	2	—	—	8	2
	—	—	3	7	—	—	3	7
	10	0	16	4	19	1	45	5
	1	9	—	—	—	—	1	9
	12	28	—	—	—	—	12	28
All Parentages	59	81	27	13	37	3	123	97
AUG. & SEPT.	32	18	28	12	119	11	179	41
	19	11	21	9	10	0	50	20
	—	—	17	13	24	16	41	29
	51	29	66	34	153	27	270	90
JULY, AUG., and SEPT. } All Parentages	110	110	93	47	190	30	393	187

PARTICULARS OF THE WEATHER ON ALL MATING DAYS AFTER JULY 4, 1908.

- July 6.—Temperature, 67 deg. at noon, 65 deg. at 1 p.m., and 62 deg. at 3 p.m.; light S. wind and clear sunshine all day. (FR.)
- 12.—Temperature, about 70 deg. between 11 a.m. and 12.30 p.m., with light S.S.W. wind; intermittent sunshine till 12.40, then thunderstorm. (FR.)
- 15.—Temperature, 63 deg. at 12, 65 deg. at 1, 64 deg. at 1.30; fresh S.W. wind; rain till 12.40, then sunshine. (R.)
- 19, 20, 21.—Temperature, 63 deg. to 64 deg. at 11 and 1; fresh N.E. wind; intermittent sunshine. These days were almost exactly alike. (R.)
- 22.—Temperature, 63½ deg. at 1.40 and 63 deg. at 3.20; very light S.E. wind, with clear sunshine all day. (R.)
- 23.—68 deg. at noon, 70 deg. at 1.30, 71 deg. at 3.20; calm; sunshine all day, hazy in afternoon. (F.)
- 24.—Maximum temperature, 74 deg.; very light S. wind; sunshine all day. (F.)
- 25.—Maximum temperature, 77 deg.; calm, rather cloudy. (F.)
- 28.—70 deg. at 1 p.m.; light N.E. wind; sunshine almost all day. (F.)

- July 30.—71 deg., with light S. wind at 1.20; sunshine all day. (F.)
- Aug. 4.—75 deg. at 11.30 and 1; light variable wind, almost continuous sunshine. (F.)
- 9.—72 deg. at 12.30, with fresh S.W. wind; 72 deg. at 1.45, with light S.W. wind; sunshine till 1.45. (FR.)
- 17.—63 deg. at 1.30; light N.E. wind, almost continuous sunshine. (R.)
- 19.—64 deg. at 12.30, 64½ deg. at 1.30, 64 deg. at 2; light N.E. wind at 12.30 and 2, almost fresh at 1.30; a few more clouds than on 17th. (R.)
- 22.—66 deg. at noon, with strong S.S.W. wind; 69 deg. at 1, with fresh S. wind; 70 deg. at 1.30, with light S. wind; 69 deg. at 2, with no wind; almost continuous sunshine from 1 to 3.30. This fine weather was in the centre of a deep storm, rough weather immediately preceding and following it. (FR.)
- 27.—68 deg. at 1.30; strong W. wind; intermittent sunshine. (R.)
- Sept. 6.—63 deg. at 12.30, with fresh W. wind; 65 deg. at 1.15, with fresh W. wind; 64 deg. at 1.30, with fresh W. wind; 65 deg. at 1.45, with light W. wind; intermittent sunshine. (R.)
- 7.—63½ deg. at 2.30, with fresh S.W. wind; continuous sunshine. (R.)

Sept. 8.— $65\frac{1}{2}$ deg. at 11.30, with light S.W. wind; 66 deg. at 1 and 1.30, with fresh S.W. wind; sunshine interrupted between 12.20 and 12.30, and at intervals later. (R.)

The thermometer was exposed in windy places in the shade outside the apiary; the temperature inside the apiary was generally about 1 deg. higher. Mr. S. Miller has kindly allowed me to compare my notes of sunshine with the records of his self-registering instrument exposed at Deal.

The date a queen is stated to have been mated was calculated as being two days before the queen appeared to have begun laying, except when that day was an unfavourable one for queen-flight, and this was the case only in September, in which month some queens started laying several days late, and a few, apparently fertilised, did not lay at all. In many cases it was not certain on which of two consecutive days a queen began to lay.* The above-listed mating days were, without exception, more favourable for flight than the unmentioned days immediately preceding and following them.

Workers having the three basal segments of the abdomen clear yellow and the middle of the fourth segment yellow are classed as golden-coloured; those having the three segments yellow and the middle of the fourth black are also classed as golden. Bright intermediates have the abdomen coloured as in pure Cyprians, medium intermediates as in ordinary pure Italians, and dark intermediates as in a cross between Italian and English bees.

It was calculated that about 20,000 drones emerged towards the end of June in Ripple Court Apiary, about 30,000 during July, and about 5,000 in August—altogether about 55,000. Roughly, about 80 per cent. of these had the first four segments yellow. The remainder had only the first three segments yellow, and were probably a kind of bright intermediate; as such they would transmit some black "blood." A few dozen darker intermediate drones were produced in June and July. In May a few dozen black drones were produced from intermediate-coloured queens, but they were not seen in July or August.

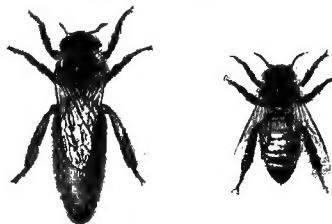
The above tables, together with the records—unfortunately not preserved complete—of matings from a number of other hives in Ripple Court Apiary, and in isolated spots near it, show that the proportion of golden to intermediate bees produced varies as the result of several conditions.

Firstly, golden queens, bred from a parentage ("V") that gave all goldens,

produced a larger proportion of goldens than did golden queens bred from parentages that gave some goldens and some intermediates. The difference in this respect between the parentage "V" and the parentage "C," which gave a large proportion of intermediates, was very noticeable in a comparison between many queens of these two parentages mated in August and September, 1908, from other hives.

Secondly, queens mated in August and September produced a larger proportion of goldens than those mated in June and July. This has been noticed for some years, and I believe is due partly to the fact that drones in normal colonies in neighbouring apiaries are turned out to die at the end of the honey-flow (while in Ripple Court Apiary they are kept several weeks longer in colonies headed by virgins, &c., and by other means), and partly to another cause to be explained later.

Thirdly, a larger proportion of goldens is produced from matings that take place at a temperature of about 63 deg. on a calm and sunny day, or in a slightly higher temperature — namely, about



THE BRITISH GOLDEN BEE.
THE GOLDEN-COLOURED QUEEN AND WORKER.

64 deg. to 68 deg.—if there is wind, than from those that take place in a high temperature—namely, about 70 deg. or more. This interesting fact was also noticed in 1907 and in the 1908 matings from other hives. The obvious reason for it is that the lower temperature and wind so restrict the flight of queens and drones that the drones of neighbouring apiaries cannot reach the queens of Ripple Court Apiary, these being mated close to Ripple Court Apiary by Ripple Court Apiary drones. It is evident that by selecting queens that have been mated in such restricting weather for testing and breeding purposes we have succeeded in breeding bees by selection. This fresh help in breeding bees by selection is likely to prove a valuable one.

The fact that queen No. 28 ("V" parentage), which was the only queen in the apiary that appeared to have been mated on August 27 (a very windy day), produced a smaller proportion of goldens than of intermediates is noteworthy. I hardly doubt that this queen was mated by a dark drone from Ripple Court

* It was only by taking this fact into consideration that a mating-day could always be found two days earlier. In some of the 1909 cases it was definitely ascertained that laying did not commence until three days after mating.

Apiary. No. 54 may have been a similar case. Excluding No. 28, we get the remarkable total of 134 goldens to only six intermediates from the fourteen matings in restricted weather, and 116 goldens to only four intermediates from the twelve matings after the middle of August, of queens bred from a parentage giving all goldens.

Ripple Court Apiary is a very favourable spot for restricted mating. The surrounding country is rather destitute of trees, and is much swept by cool winds, the prevailing north-easterly and south-westerly winds both blowing off the open sea, which is four and seven miles off in these respective directions. Perfectly calm days are rare. On sunny days in summer, when it is warm inland, the maximum temperature is generally about 5 deg. to 10 deg. lower and the wind stronger than in warm places inland. But there is more sunshine and the nights are warmer than inland.* The apiary is now sheltered from wind by a belt of trees and shrubs, chiefly Austrian pine, goat willow, sycamore, and lime, planted round it twelve years ago. Whichever way the wind blows, there is a sheltered area just outside the apiary, in which I believe many queens are mated.

No bees are kept within half a mile of Ripple Court Apiary, and not many within two and a half miles. The nearest bees have been very little affected by the Ripple Court Apiary drones, most of them being still black, and no goldens have been produced. The queens are mated in June and early in July before many Ripple Court Apiary drones are on the wing.

As far as I have been able to observe, most queens in Ripple Court Apiary are mated between 12.30 and 2.30 p.m., this being usually the warmest period of the

* To give some idea of the difference in climate between this coast and inland, the following figures have been extracted from the "Weekly Weather Report," of the Meteorological Office, 1906, Appendix III.

35 YEARS' AVERAGE TEMPERATURE.

	July.	August.		
Average maximum.	Average minimum.	Average maximum.	Average minimum.	
Dungeness....	67° ¹	56° ⁰	67° ⁵	56° ⁵
Oxford.....	70° ⁴	53° ⁶	69° ²	52° ⁹

25 YEARS' AVERAGE SUNSHINE.

	July.	August.
Littlestone-on-Sea, { near Dungeness }	231	201 hours.
Oxford.....	203	185

On days that are warm and sunny inland the difference in maximum temperature between Dungeness and Oxford is generally much greater than these figures show, but on cold, dull days Dungeness generally has a higher maximum than Oxford. Notice that at Dungeness August is warmer than July, but at Oxford July is warmer than August.

The excessive sunshine, warm nights, and numerous wild flowers are very favourable for bee-rearing. Humble-bees are abundant, and many rare and tender species of solitary bees are to be found in the neighbourhood. A new bee to Britain, *Sphecodes rubicundus*, was discovered in the grounds at Ripple Court in 1895, and another, *Cilissa melanura*, at St. Margaret's Bay in 1897.

day. On August 28, 1907, I saw a queen, aged twenty-one days, enter a hive, bearing the signs of having just mated, as early as 11.10 a.m. The temperature was then 65 deg., with scarcely any wind and a clear sky. The previous day was one of

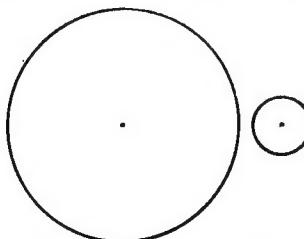


Diagram showing difference between a range of flight of 1 mile and one of $\frac{1}{4}$ mile (440 yards).

restricted flight, and it followed a long period unfavourable for flight.

The latest time of day I have seen a queen fly was at 5 p.m., on July 16, 1906.* There had been a very strong S.W. wind for four days, but on this day it moderated a little between 4 and 5 p.m., and the temperature, which had been no higher than 64 deg., rose to 65 deg. About 5 p.m. I also saw a number of drones circling and darting about in the air only four or five yards to the leeward of a colony in the apiary; they continued to do this for about five minutes, and were evidently looking for queens. This was an interesting case of extremely restricted amorous flight, which was no doubt fruitless, for no queens appeared to have been mated on that day.

In "free" mating weather a queen is seldom or never mated before the second day of flight. For a queen to be mated in restricting weather the preliminary flights usually extend over several days. The ages at which most queens in the tables (pages 1 and 2) were mated in "free" weather were six days and nine days after hatching; none were mated before the sixth day. In restricting weather most queens were mated on the twelfth, thirteenth, and fifteenth days, and none before the twelfth day. Owing to an unusually prolonged period of unfavourable weather in the early part of July, and to another in the latter part of August and beginning of September, many more queens were mated after the fifteenth day in 1908 than in most years.

To secure many cases of restricted mating it is necessary that the weather be seldom warmer than restricted mating weather, because queens and drones are very susceptible to a fall in temperature, and would not fly at low temperatures if

* It is possible that queens and drones might be induced to fly late in the day after other drones have retired by keeping the hives in a cool and dark place—for instance, a cellar or well—until afternoon.

they could get higher ones at intervals of two or three days. Drones will fly at a lower temperature, and probably have a wider range of flight, than queens. The lowest mating temperature is a degree or two higher than the lowest flying temperature.

I have never known mating to take place on a day with a maximum temperature below 62 deg., and believe that it does not readily occur at 63 deg. or 64 deg., unless there are a great many drones and also relatively many queens flying. When many queens are flying, the air near the apiary is full of drones darting about in all directions on their trail. Many of the drones follow one another, and they frequently form little knots or flocks, which break up after a few erratic swoops. If one lies on the ground about fifty yards from the apiary scanning the sky, the little flocks constantly appear, but at 200 yards they are seldom seen. The presence of so many ardent drones near the apiary must induce many matings to take place there

Restricted mating weather has undoubtedly aided the work of breeding bees by selection in Ripple Court Apiary ever since it began. I have found no evidence that fertilisation is not well accomplished when mating takes place in restricting weather. Of course, some queens are lost through adverse weather, but these are no doubt the weaker ones, and this process, continued for many generations, should result in the development of a very hardy breed of bees. There is every indication that this has been the case in Ripple Court Apiary. For several years past no colonies have been lost in winter, and there has been no spring dwindling.

1909 RESULTS.

The summer of 1909, although unfavourable for bee-keeping in most parts of Britain, proved a better one for the particular work carried on in Ripple Court Apiary than 1907 or 1908, and a larger number of queens were reared and mated than in either of those years.

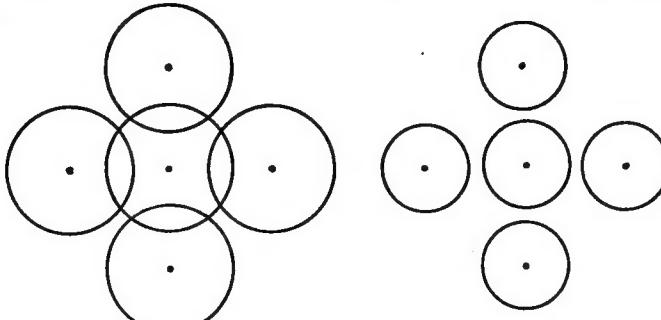


Diagram showing how a slightly restricted range of flight may completely isolate an apiary for breeding purposes. The dots represent imaginary apiaries and the circles ranges of flight. The ranges of flight of queens and drones are not shown separately.

and quickly. I think it likely that many of the matings on "free" days, and all on restricted days, occur within about 200 yards of the apiary.

In hunting for queens drones naturally select open fields, and specially like rising ground; they avoid shady places.

There is no doubt that on most "free" days flight is not altogether unrestricted. There is reason to suppose that the range of flight is smaller in August than in July, on account of the lessened honey-flow and activity.

It was noticed that during a period of restricted mating weather at the end of June, 1908, many queens failed to get mated; but during periods of similar weather in August and September almost all the queens were mated, despite the fact that the honey-flow had ended, which made mating more difficult. This seems to indicate that the young drones flying at the end of June may not have been mature.

Although two years' observation had convinced me of the usefulness of restricted-mating weather, the 1908 records that were preserved do not make it very plain. The successful matings recorded as occurring in July which seemed attributable to restricted-mating weather were very few, and it is not certain that all of them did take place in restricting weather. It is true that many successes resulted from matings in restricting weather after August 4, but there is no evidence to show how far these were due to mating late in the season. I therefore hoped that, with suitable weather in 1909, a larger number of matings might supply some definite evidence as to the value of restricted-mating weather. Fortunately the weather could scarcely have been more suitable, and the results, which are summarised below, clearly indicate the importance of restricted-mating weather. The figures speak for themselves, but it may be remarked that the strongest evi-

dence they furnish in support of the value of restricted-mating weather is found in the fact that the twenty-two matings attributable to nearly a week of continuous restricted-mating weather at the end of July produced 27 per cent. more goldens than the thirty-three matings attributable to nearly two weeks of continuous free-mating weather in August, the law that July matings produce a smaller proportion of goldens than August matings having been, in these periods, overruled by the weather. The fact that these periods were preceded, separated, and followed by periods during which no matings were possible makes this result the more reliable.

Restricted-mating weather is an attribute peculiar to the British climate. It scarcely occurs in such great bee-keeping countries as the United States, Italy, and France. In England it reaches its best on the coasts and in high localities. There must be many good spots for restricted mating in Scotland and Ireland.

The 1909 figures also show how unreliable and sometimes misleading an insufficient number of observations may be in an investigation of this kind.

LIST OF THE MATING DAYS AT RIPPLE COURT APIARY IN 1909 AFTER JULY 5, WITH THE COLOUR RESULTS FROM THE 123 TESTED QUEENS THAT APPEARED TO HAVE BEEN MATED ON THESE DAYS.

Mating Day.	Weather on Mating Day.	Number of Queens apparently mated on this day.	Approximate proportion of Golden-Coloured and Intermediate-Coloured Workers Produced.				Percentage of Golden-Coloured Workers.
			Golden	Intermediate.	Golden	Intermediate.	
July 9	FR	10	14 to 86				
" 13	FR	4	13 " 27	54 to 166	{	25%	(in FR weather)
" 14	FR	8	27 " 53				
" 17	R	6	38 " 22	71 to 39	{	65%	
" 18	R	5	33 " 17	50 " 60	{	41%	(in R weather)
" 19	FR	11	52 " 58	82 to 118	{		(in FR weather)
" 20	R	2	7 " 13				
" 27	R	6	40 " 20				
" 28	R	5	46 " 4	158 to 62	{	72%	(in R weather)
" 31	R	0	—				
Aug. 1	R	9	65 " 25				
" 4	FR	7	42 " 28				
" 5	FR	6	10 " 50	63 to 97	{	39%	
" 6	FR	2	6 " 14				(in FR weather)
" 7	FR	1	5 " 5				
8 & 9	FR	0	—				
" 11	F	3	16 " 14				
" 12	F	4	26 " 14				
" 13	F	7	36 " 34	85 to 85	{	50%	
" 14	F	2	7 " 13				(in F weather)
" 15	F	1	0 " 10				
" 17	FR	0	—				
" 28	R	15	Queens, evidently mated on these days,				
" 29	R						
Sep. 3	R						
" 10	R		commenced laying on various dates in September.	140 to 10	{	93%	(in R weather)
" 11	R						
" 12	R						

F = Free mating weather. FR = Less free mating weather. R = Restricted mating weather.

All the queens, except two, were bred from parentages producing only golden-

coloured workers. Ninety-three of the queens were grand-daughters of "V" and twenty-eight were grand-daughters of "A" (see page 1). The conditions as regards isolation and drone-breeding did not differ materially from those in 1908. All the drones were bred from golden-coloured queens, and roughly about 80 per cent. of them from queens producing only golden-coloured workers.

The proportion of goldens to intermediates produced by each union could only be approximately estimated; moreover, it seemed to vary a little. Most of the 1908 unions producing golden majorities were re-tested by a more accurate method in June, 1909; it was then found that several of the 8 to 2 were nearer 7 to 3. The result from No. 55 (1908) was unique; probably a second testing would have shown it to be all goldens or all intermediates. It may be observed here that every year a few of the golden-coloured queens bred from parentages producing some goldens and some intermediates had the scutellum and the tip of the abdomen darker than in typical golden-coloured queens and were evidently heterozygous.

Another question I set myself to investigate in 1909 was how far the greatest degree of isolation obtainable would affect results. For this purpose five virgin queens from parentages producing only goldens, and two or three hundred drones also from parentages producing only goldens, were placed in baby-nuclei at Hope Farm, a very isolated spot on the open downs close to the sea-cliffs, about midway between the villages of Kingsdown and St. Margaret's Bay. Careful inquiry in the neighbourhood failed to reveal the existence of any colonies of bees within a mile of Hope Farm, and as the spot is rather more than half surrounded by sea, it follows that there were fewer bees by more than a half living beyond that distance than in an equally thickly populated district inland. One of the queens appeared to have mated on August 4; she produced only intermediate-coloured workers. Two more queens appeared to have mated on August 7; one of them produced only intermediates, the other produced one golden to nine intermediates. The two remaining queens appeared to have mated on August 14; they both produced intermediates only. Evidently none of these queens mated with golden-coloured drones, the extent of isolation not being nearly sufficient to ensure pure mating.

I do not know how far queens and drones can fly—in America workers have been observed to fly four to seven miles in search of food*—but I would not rely on isolation for pure mating anywhere in

* See *Gleanings in Bee-Culture*, vol. xxxvii., page 577.

Britain, except on an isolated island. Supposing three miles were the limit of flight of queens and drones, one would have to ascertain by careful inquiry that no bees were kept within a radius of over six miles, and then one could not be sure that no colonies existed in hollow trees or in buildings, or that swarms might not settle in the district.

CONCLUSION.

The foregoing evidence leaves no room for doubt that the British Golden bee is bred by selection in the strict sense of the term that plants and animals in which improvement has been made have been bred by selection, the selection of the fathers having been effected by colour,* aided by (1) large num-

Breeders of every kind of animal and plant are agreed that the best way to improve a character is to select and breed for that character only in every successive generation. Consequently I have had to rather neglect other objects, as, for instance, the improvement of temper. Yet the temper of British Goldens has become gentle of its own accord, probably as the result of in-breeding, and it is doubtful if it could have been improved any better by selection: even the hybrids are better-tempered than ordinary bees. No attempt has been made to increase the golden colour, and it does not extend over so large a portion of the body as in some American Goldens. There is, however, one character, the quality called "constitutional vigour," which no breeder



RIPPLE COURT APIARY.

bers of drones, (2) isolation as far as is practicable, (3) restricted-mating weather, and (4) mating late in the season.

As was stated at the commencement of these notes, the breeding by selection has been carried on with the object of improving the honey-producing character in the British climate, and each spring the best honey-gatherers have been very carefully selected for breeding purposes from the pure stock bred the previous year. The result has been a steady improvement noticed, not only in Ripple Court Apiary, but in the reports received from people in different parts of the kingdom who have tried British Goldens.†

* For details of this method of breeding by selection, see my papers in the BRITISH BEE JOURNAL, vol. xxxiv., page 132, and vol. xxxv., pages 21 to 23.

† See Sladen's "Catalogue of Bees and Queens," tenth edition.

can afford to ignore, and which I regard as of the greatest importance in bees. Fortunately, this character is closely associated with honey-production; it is also connected with hardiness, prolificness, and disease-resisting power, and all these good qualities have been worked for with success. There are many indications that British Goldens are growing very hardy: the golden-coloured bees were noticed to be busily bringing in honey and pollen on several days in May, 1909, when the temperature was only 52 deg. to 54 deg. with a strong breeze; there was a marked diminution in the proportion of queens that failed to get mated in Ripple Court Apiary this year, and there is good reason for believing that several queens were mated at the beginning of September in a temperature of about 61 deg., which is

lower than that noted in any previous year. No difficulty has been found in maintaining great prolificness in spring, which is so valuable a feature in good Italians.

A great many good reports, some of them from very cold and bleak localities, have been received respecting the half-bred bees produced by British Golden queens mated to ordinary native drones.* In many cases these bees have proved extraordinarily industrious, hardy, and prolific. With bees, as with cattle, sheep, poultry, and fruit, the greatest profit is often obtained from half-breds. It is fortunate that this is the case, because, in ordinary circumstances, pure mating is so rare and uncertain that, in introducing a new breed into his apiary, the bee-keeper who works for honey is compelled to let it cross with the local variety. The crossing imparts energy, which seems to result from the blending of the golden and black colours, or of characters associated with them. This added energy, which means so much more honey gathered, would have been lost had the bred bee been black. Besides, it has been shown that it would be very difficult, if not impossible, to breed a black bee by selection in this country.

ADDITIONAL NOTES.

Like ordinary English black bees, British Goldens are easily shaken from their combs and are inclined to run about the hive when disturbed. In these particulars they differ and may be distinguished from American Goldens and from Italians.

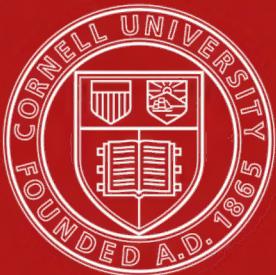
The objection may be raised that, considering the impossibility of knowing which drone out of thousands a queen may meet, the breeding by selection on the male side cannot be properly accomplished. But if we look at the work of plant breeders we see that a similar uncertainty often exists as to which flower will supply the pollen by which the seed is fertilised. Further, in cases where characters that do not show themselves in the flowers, such as the size, shape, or other qualities of seeds or fruits, are bred for, the selection of flowers is useless. It is only essential that no flower shall be employed that is not of the selected parentage or strain. I think that even were it possible to select single drones for breeding from, it would not be advisable, for we may be sure that the honey-bee depends partly upon the natural selection of drones for its vigour and usefulness. It is not

asserted that one drone transmits exactly the same characters as another, but this uncontrolled element of variation is reduced to a negligible quantity by the employment of pure stock and continuous careful selection.

Of late years much progress has been made in the general science of breeding, and one of the valuable points that have been brought to the front is the importance of breeding from specimens that have been proved to be best able to transmit their desirable qualities to their offspring. In the work carried on in Ripple Court Apiary every queen bred from has, of course, been proved to produce industrious and vigorous workers; but it is desirable to go further, and to breed from queens that have been proved to be best able to transmit to their queen-daughters the power to produce such workers and any other qualities bred for. For example, the colonies produced by the daughters of the "V" queen (all of which were golden-coloured), when tested for utility and vigour in 1909, did much better, on the average, than the colonies produced by the golden-coloured daughters of the "C" queen; consequently, a great number of queens were bred from the "V" queen and her daughters in 1909, but none were bred either from the "C" queen or from any of her daughters. It is true that this method of breeding increases in-breeding, but its value for fixing, maintaining, and improving any particular type is undeniable, and breeders of other animals have found that the danger of deterioration resulting from close in-breeding is not so great as has been supposed, provided the breeding stock is vigorous and healthy. So far no sign of any ill-effect of in-breeding has been detected in the British Golden breeding stock.

Up to the present the working of this method of breeding has been somewhat hampered by the work of quickly developing a distinctly British variety, this having involved selecting a fresh generation each year; but now that British Goldens have become established as a separate breed, the work of selection may well be spread over two years if it can be accomplished more thoroughly. All the breeding queens selected in 1909, also a number of the daughters of each of them, are being wintered. The testing of these daughters for utility and vigour in 1910, together with the re-testing of the breeding queens themselves, will probably show very clearly which are the best of the breeding queens, and from these best queens I hope to breed largely.

* Sladen's "Catalogue of Bees and Queens," tenth edition.



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